Project: **1311**
Project title: **The importance of upper-troposphere aerosol formation for low- and mid-troposphere aerosol concentrations**
Principal investigator: **Anna Possner**
Report period: **2025-07-01 to 2026-04-30**

Resources utilization report

Table 1: Overview of project resources utilization from 2025-07-01 to 2026-04-11. All entries are given in Node hours.

Category	Amount
Granted	5'001
Consumed	3'750
Expired	1'064
Remaining	1'251

During this period, resources were allocated to two main areas: sensitivity tests complementing previous long-term EMAC global simulations of upper tropospheric aerosol transport, and simulations of a CAFE-Brazil model intercomparison case. The modelling activities encompassed preprocessing, model setup and testing, execution of production experiments, and postprocessing of model outputs.

Sensitivity tests to complement EMAC's long term simulations

To assess the robustness and significance of the transport time scales and pathways identified from EMAC 10-year simulations of idealized tropical upper-tropospheric aerosols, we extended the 12-pulse-tracer approach described in the previous report (one tracer per month, per region) to include 4 more sets of 12 pulse tracers, focused on one specific region but varying transport and source region assumptions. Previously, we had run a 2.5 year simulation case in which 12 tracers, maintained constant for one month of the year each within different UT source regions (Amazon, Africa, Maritime Continent, and Tropics) were transported via resolved advection, parameterized convection and vertical diffusion, and evolved according to dry deposition, sedimentation and wet scavenging. By the taking the time it takes for each tracer to reach a given fraction of the UT value at a given level, and averaging over the 12 tracers in each tests, we are able to retrieve a representative measure of the fastest transport timescales and their impact, depending on the source region. In order to identify the impact of potential error sources in our analysis, such as the convective and turbulent diffusion parameterizations, and the height and size of aerosol particles, we turned the former two processes off and varied the later two aerosol properties, for separate sets of 12 pulse tracers initialized over the Amazon only. This was achieved through an extra 2.5 year EMAC simulation.

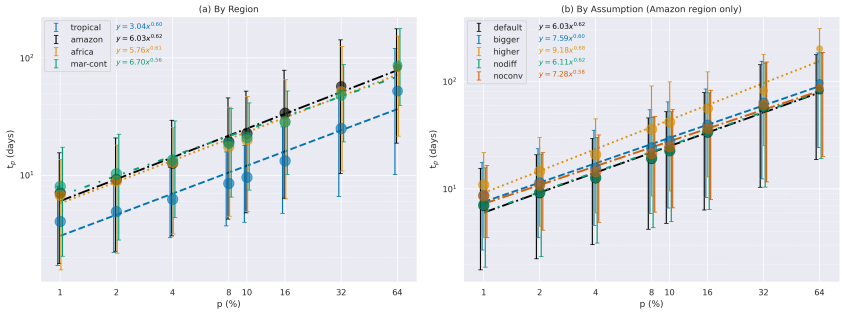

Figure 1: Time-to-threshold t_p at 500 hPa, below the UT forcing regions, for varying thresholds. (a) Different regional tracers in the control run, and (b) Amazon regional tracer from different sensitivity experiments. Markers represent area averages, and the error bars indicate the interval between the 10^{th} and 90^{th} percentiles of t_p. Grid points where the threshold p is never reached by the end of the simulation are excluded. Marker size is proportional to the number of valid grid points. The straight lines illustrate power-law fits obtained via linear regression in log–log space, applied to the valid data points. The fitted parameters (slope and intercept) are shown in the upper-left corner, with text color matching the corresponding lines.

Figure 1b shows that the impact of parameterized transport components (convection and turbulent diffusion) is very small overall. The sensitivity of t_p to convection and turbulent diffusion is generally smaller than the sensitivity to the tracer initialization assumptions regarding size and height. Among the factors tested, the height of the source region emerges as the dominant control on transport timescales.

CAFE-Brazil model intercomparison run

The Chemistry of the Atmosphere: Field Experiment in Brazil (CAFE—Brazil) took place between 30 November 2022 and 29 January 2023 (Curtius et al. 2024). Simultaneously to HALO flights during CAFE-Brazil, physical and chemical properties of atmospheric constituents in the surface layer and part of the boundary layer were measured in the Amazon Tall Tower Observatory and the ATTO-Campina site. On 14 January 2023, a westward-propagating squall line passed over ATTO/Campina early in the morning. Meanwhile, HALO (Research Flight number 15, RF15) sampled the free troposphere and boundary layer ahead of the line, 550-km West-Northwest of Manaus, before flying Southeast to sample the free and upper troposphere in the neighborhood of the squall line. This case was selected for a model intercomparison effort to which we submitted ICON-NWP results.

- Simulation period: From 21:00 of 13.01.2023 to 03:00 of 15.01.2023 (30 hours)
- Initialization and BC data: IFS analyses (ECMWF), TL1279
- Coordinates of grid center: (ATTO): -2.1° lat, -59° lon
- Domain configuration: Two one-way nested domains of 1.6km and 0.8km resolution, respectively
- Model configuration: 2-moment microphysics, parameterized shallow convection, explicit deep convection

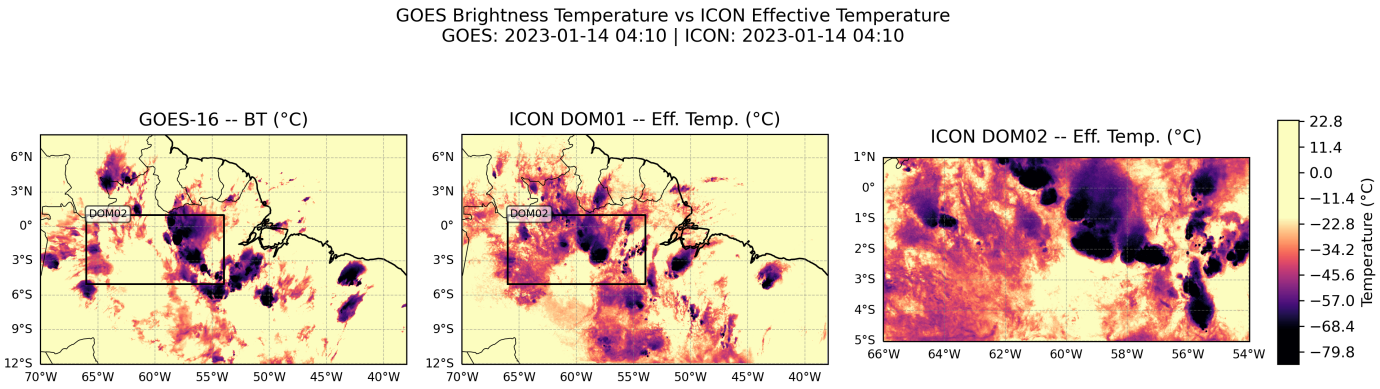

Figure 2: Satellite observation and ICON simulation results for January 14, 04:10 UTC. (left) GOES 16, band 13 (10.3 μm). (center and right) Blackbody ("effective") temperature derived from the outgoing long-wave radiation at the top of the atmosphere from the 1.6-km and 0.8-km resolution ICON domains respectively.

Figure 2 illustrates the results of the submitted ICON simulation. The test demonstrates ICON's relatively good skills in representing the squall line event that occurred on January 14, 2023. Compared to the observations (satellite image in Fig. 2, left), the ICON simulation captures the convective patterns reasonably well, especially the squall line located in the central Amazon. However, further analysis (not shown) evidenced that, in contrast with the observations, this system is relatively short-lived in the ICON simulation.

Amazonian Squall Lines

Long-term data storage

The requested long-term data storage of 20 TiB was not accessed during this allocation period, since Hernández Pardo et al. (ACPD) submitted at the end of September 2025 is still under review (one review still pending). Once the publication is finalised, the simulation results will be archived to fulfil journal archiving requirements. Dr. Hernandez Pardo left the group in August 2025 ahead of her contract for another permanent research post. Thus the originally planned CM1 experiments were not conducted.